

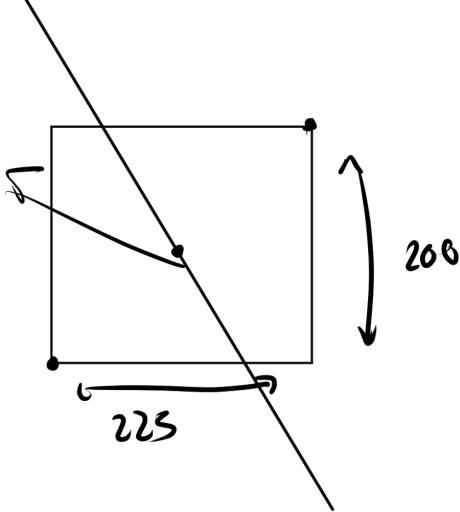
Problem Set Group 6:

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Since the object is symmetric

I_{yz} does not exist

centroid $\bar{y} = 100$

centroid $\bar{z} = 112.5$

$$I_z = \frac{225 (200)^3}{12} = 150000000$$

$$I_y = \frac{200 (225)^3}{12} = 189843750$$

$$\sigma_x = \frac{M_y(z)}{I_y} - \frac{M_z(y)}{I_z}$$

compression $(112.5, -100)$

assume $\theta = 45^\circ$

tension $(-112.5, 100)$

$$\sigma_t = 400$$

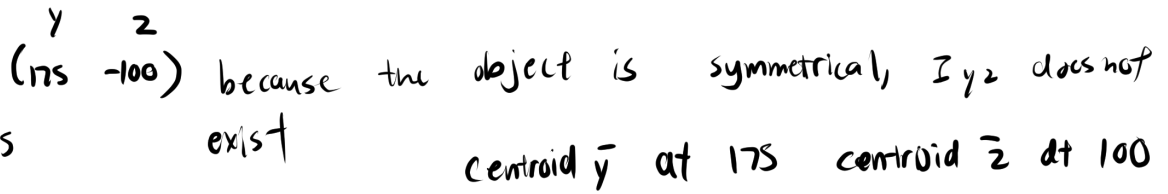
$$\sigma_c = 160$$

$$\sigma_t = \frac{M \sin 45^\circ (112.5)}{189843750} - \frac{M \cos 45^\circ (-100)}{150000000} = 400$$

$$\sigma_c = \frac{449220778.6}{1000^2} = 449.22 \text{ kN}$$

$$\sigma_t = \frac{M \sin 45^\circ (-112.5)}{189843750} - \frac{M \cos 45^\circ (100)}{150000000} = 160$$

$$\sigma_c = \frac{-112305194.7}{1000^2} = -112.31 \text{ kN}$$



$$\sigma_{yz} = -\frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

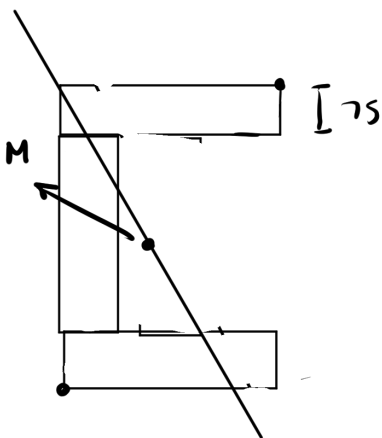
$$I_2 = 631250000$$
$$I_y = 107631250$$

assume $\theta = 45$

$$\sigma_k = 400$$

$$\sigma_c = 100$$

$$\sigma_c = \left(- \frac{M \cos 45 (175)}{431250000} + \frac{M \sin 45 (-100)}{107031250} \right) = 100 \quad \mu = \frac{116729140.2}{1000^2} = -116.73 \text{ N/N}$$



because the object is symmetrical, I_{yz} does not exist
 centroid $\bar{y}$ at 175 centroid $\bar{z}$ at 120.83

$$\sigma_x = -\frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

solving for I_z

	i	d (distance from $\bar{y}$)	A	Ad^2	i + Ad^2
top	$\frac{200(75)^3}{12}$	$100 + \frac{75}{2}$	$75(200)$	283593750	290625000
column	$\frac{75(200)^3}{12}$	0	$75(200)$	0	50000000
bottom	$\frac{200(75)^3}{12}$	$-100 - \frac{75}{2}$	$75(200)$	283593750	290625000

$$I_z = 631250000$$

solving for I_y

	i	d (distance from $\bar{z}$)	A	Ad^2	i + Ad^2
top	$\frac{75(200)^3}{12}$	-20.833	$75(200)$	6510416.667	56510416.67
column	$\frac{200(75)^3}{12}$	41.667	$75(200)$	26041666.67	33672916.67
bottom	$\frac{75(200)^3}{12}$	-20.833	$75(200)$	6510416.667	56510416.67

$$I_y = 146093750$$

$$M_z = M \cos \theta$$

$$M_y = M \sin \theta$$

compression: 120.833, 175

tension: 79.167, -175

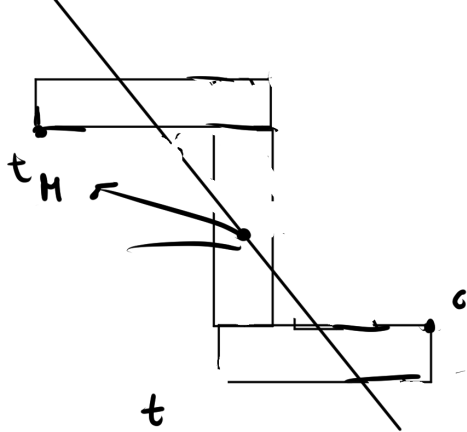
assume $\theta = 45$

$$\sigma_t = 400$$

$$\sigma_c = 100$$

$$\sigma_c = \left(-\frac{M \cos 45 (175)}{631250000} + \frac{M \sin 45 (-120.833)}{146093750} \right) = 100 = M = \frac{128061945}{1000^2} = -128.06 \text{ kN}$$

$$\sigma_t = \left(-\frac{M \cos 45 (-175)}{631250000} + \frac{M \sin 45 (79.167)}{146093750} \right) = 400 = M = \frac{690601839.7}{1000^2} = 690.6 \text{ kN}$$



solving for I_z

	i	d (distance from $\bar{y}$)	A	Ad^2	$i + Ad^2$
top	$\frac{200(75^3)}{12}$	$100 + \frac{75}{2}$	75(200)	283593750	290625000
column	$\frac{75(200)^3}{12}$	0	75(200)	0	50000000
bottom	$\frac{200(75)^3}{12}$	$-100 - \frac{75}{2}$	75(200)	283593750	290625000

$$I_z = 631250000$$

solving for I_y

	i	d (distance from $\bar{z}$)	A	Ad^2	$i + Ad^2$
top	$\frac{75(200)^3}{12}$	62.5	75(200)	108593750	108593750
column	$\frac{200(75)^3}{12}$	0	75(200)	0	2031250
bottom	$\frac{75(200)^3}{12}$	-62.5	75(200)	108593750	108593750

$$I_y = 224218750$$

solving for I_{yz}

	y	z	A	$y z A$	I_{yz}
	137.5	62.5	75(200)	128906250	257812500
	0	0	75(200)	0	
	-137.5	62.5	75(200)	128906250	

assume $\theta = 45$

$$M_z = M \cos \theta$$

tension : -137.5, -100

$$\sigma_t = 400$$

$$M_y = M \sin \theta$$

compression : 137.5, 100

$$\sigma_c = 100$$

(137.5)

$$\sigma_c = \frac{M \cos 45 (224218750) + M \sin 45 (257812500) (100)}{(224218750)(631250000) - 257812500^2} = \frac{M \sin 45 (631250000) + M \cos 45 (257812500)}{(224218750)(631250000) - 257812500^2}$$

$$= 400 \quad M \cos 45 = \frac{57353802}{1000^2} = 573.54 \text{ kN}$$

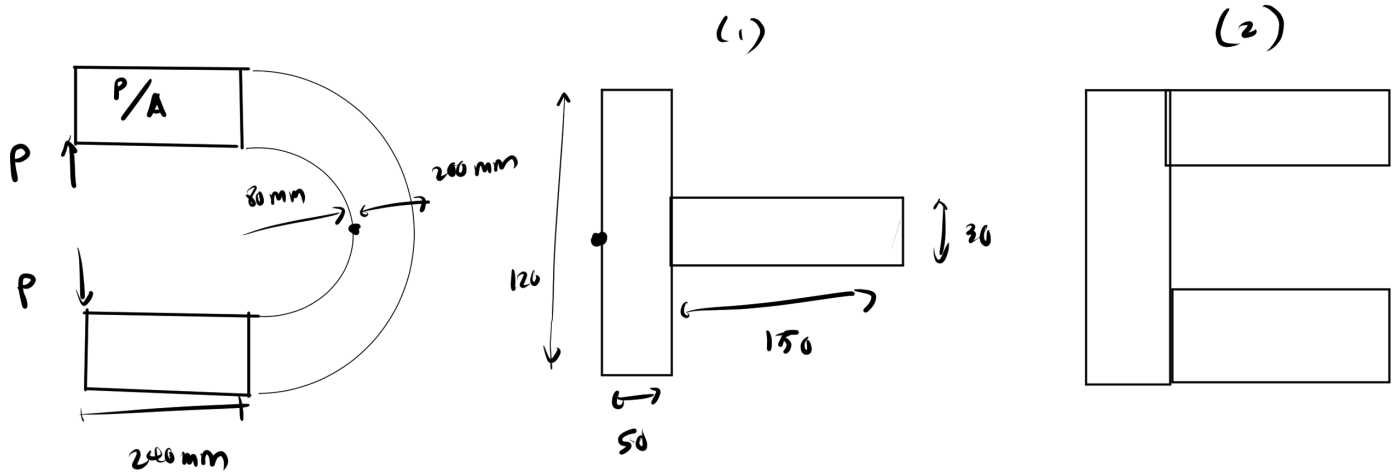
$$M_c = \frac{143784505.5}{1000^2} = -143.38 \text{ kN}$$

applying the same at (137.5, 100)

	tension	compression
I	466.92	-116.73
C	690.6	-128.06
L	573.54	-143.38
□	449.22 kN	-112.31 kN

the C shape has the highest moment capacity

$$\text{Ave SN} = (77 + 26 + 79 + 38) / 4 = 53.5 \quad P = 100 + 53.5 \quad P = 153.5$$



for section (1)

$$A = (0.12)(0.05) = 0.006 \text{ m}$$

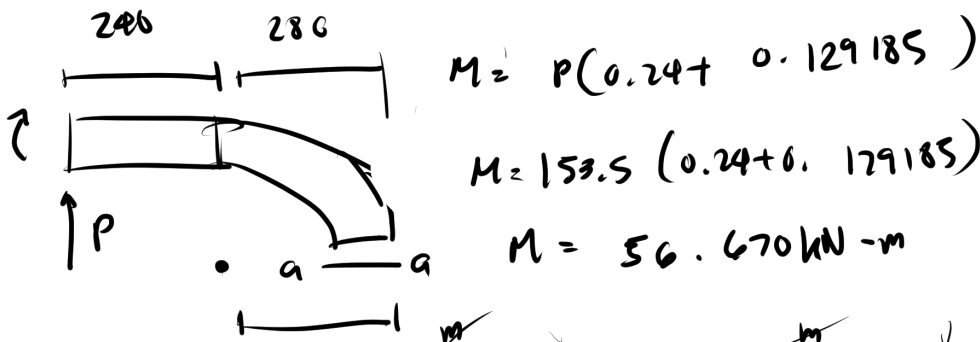
$$(0.03)(0.15) = 0.0045 \text{ m}$$

$$\bar{r} = \frac{0.006(0.105) + 0.045(0.205)}{0.006 + 0.045}$$

$$\bar{r} = 0.147857$$

$$\bar{r} \int \frac{A}{\bar{r}^2} = 0.12 \left(\ln \frac{0.13}{0.08} \right) + 0.03 \left(\ln \frac{0.23}{0.13} \right) = 0.081279$$

$$R = \frac{0.105 \text{ m}^2}{0.081279 \text{ m}} = 0.129185 \text{ m} \quad \text{or} \quad 129.185 \text{ mm}$$



$$M = P(0.24 + 0.129185)$$

$$M = 153.5(0.24 + 0.129185)$$

$$M = 56.670 \text{ kN-m}$$

$$\sigma_A = \frac{(56.670) \left(0.129185 - 0.08 \right)}{(0.0105) \left(0.08 \right) \left(0.147857 - 0.129185 \right)} = 177714.1 \frac{\text{N}}{\text{m}^2} = 177.714 \text{ MPa}$$

$$\sigma_N = \frac{153.5 \text{ kN}}{(0.0105)(1000)} + 177.714 \text{ MPa} = 192.333 \text{ MPa} \quad (\text{tension})$$

$$\sigma_A = \frac{(56.670) (0.129185 - 0.28)}{(0.0105) (0.28) (0.147857 - 0.129185)} = -155696 \text{ KN-m}$$

$$= -155.69 \text{ Mpa}$$

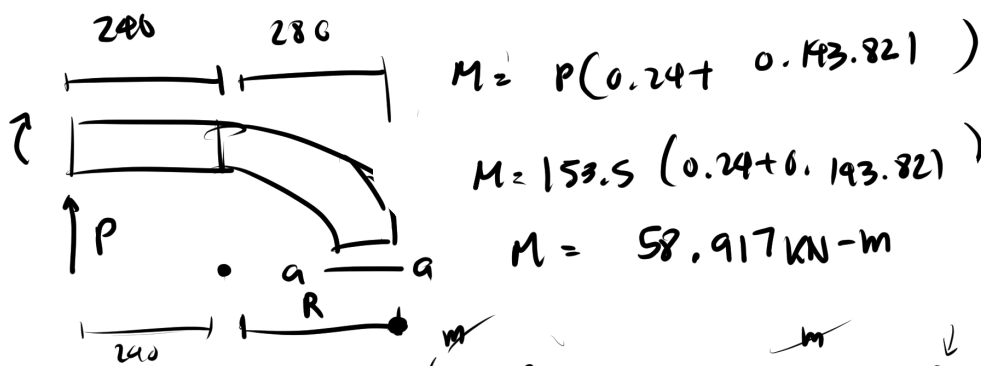
$$\sigma_N = \frac{153.5 \text{ KN}}{(0.0105) (1000)} - 155.690 = -141.071 \text{ Mpa (compression)}$$

for section (2)

$$A \quad \begin{aligned} (0.12) (0.05) &= 0.006 \\ (0.03) (0.15) &= 0.0045 \\ (0.03) (0.15) &= 0.0045 \end{aligned} \quad \begin{aligned} &2(0.205) (0.0043) + 0.105 (0.006) \\ &0.015 \\ &7 = 0.165 \end{aligned}$$

$$\bar{x} \int \frac{A}{x} = 0.12 \left(\ln \frac{0.13}{0.08} \right) + 0.03 \left(\ln \frac{0.28}{0.13} \right) + 0.03 \left(\ln \frac{0.28}{0.13} \right)$$

$$R = \frac{0.165 \text{ m}^2}{0.104296} = 0.15821 \text{ or } 158.21 \text{ mm}$$



$$M = P(0.24 + 0.15821)$$

$$M = 153.5 (0.24 + 0.15821)$$

$$M = 58.917 \text{ KN-m}$$

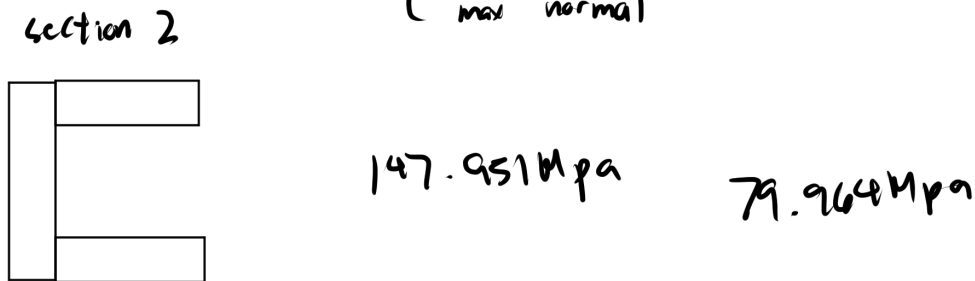
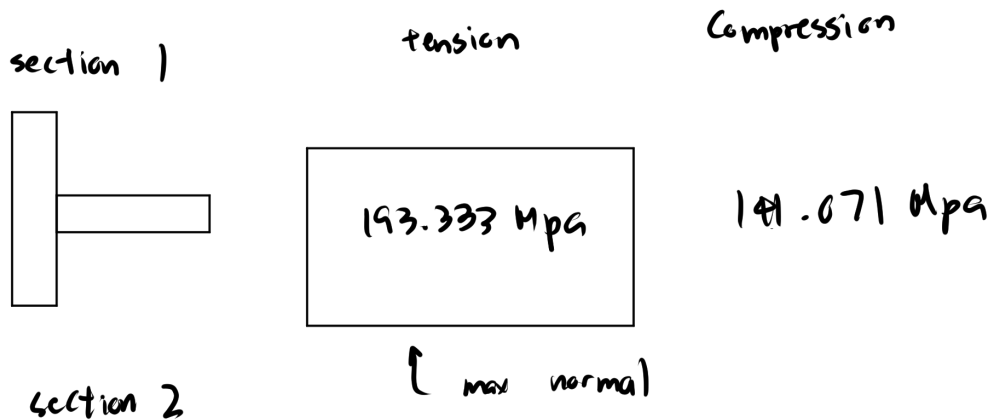
$$\sigma_A = \frac{(58.917) (0.15821 - 0.08)}{(0.0105) (0.08) (0.165 - 0.15821)} = 147950.6 \text{ KN-m}$$

$$= 147.951 \text{ Mpa}$$

$$\sigma_N = \frac{153.5 \text{ KN}}{(0.015) (1000)} + 147.951 \text{ Mpa} = 158.184 \text{ Mpa (tension)}$$

$$\sigma_A = \frac{(58.917) \left(0.143821 - 0.28 \right)}{\left(0.0105 \right) \left(0.28 \right) \left(0.165 - 0.143821 \right)} = -90.197 \text{ kN-m} = -90.197 \text{ Mpa}$$

$$\sigma_N = \frac{153.5 \text{ kN}}{(0.015)(1000)} - 90.197 \text{ Mpa} = -79.964 \text{ Mpa} \quad (\text{compression})$$



section 1 has the highest tension and compression forces